PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 040936PC	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. **PCT/AU2004/001080**	International filing date *(day/month/year)* 12 August 2004	Priority date *(day/month/year)* 15 August 2003
International Patent Classification (IPC) or national classification and IPC **Int. Cl.**[7] C25B 1/04, C01B 3/02, 3/10		
Applicant PROTEGY LIMITED et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. [X] *(sent to the applicant and to the International Bureau)* a total of 3 sheets, as follows:
      - [ ] sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - [ ] sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. [ ] *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:

[X]	Box No. I	Basis of the report
[ ]	Box No. II	Priority
[ ]	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
[X]	Box No. IV	Lack of unity of invention
[X]	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
[ ]	Box No. VI	Certain documents cited
[ ]	Box No. VII	Certain defects in the international application
[ ]	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of the report
8 March 2005	1 December 2005
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **DAVID K. BELL** Telephone No. (02) 6283 2309

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/001080

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language which is the language of a translation furnished for the purposes of:

   ☐ international search (under Rules 12.3 and 23.1 (b))

   ☐ publication of the international application (under Rule 12.4)

   ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

   ☐ the international application as originally filed/furnished

   ☒ the description:

   pages **1 to 10 and 12 to 16** as originally filed/furnished
   pages* **11** received by this Authority on **8 March 2005** with the letter of 8 March 2005
   pages* received by this Authority on with the letter of

   ☒ the claims:

   pages as originally filed/furnished
   pages* as amended (together with any statement) under Article 19
   pages* **17 and 18** received by this Authority on **15 November 2005** with the letter of 15 November 2005
   pages* received by this Authority on with the letter of

   ☒ the drawings:

   pages **1 and 2** as originally filed/furnished
   pages* received by this Authority on with the letter of
   pages* received by this Authority on with the letter of

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

   ☐ the description, pages
   ☐ the claims, Nos.
   ☐ the drawings, sheets/figs
   ☐ the sequence listing (*specify*):
   ☐ any table(s) related to the sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

   ☐ the description, pages
   ☐ the claims, Nos.
   ☐ the drawings, sheets/figs
   ☐ the sequence listing (*specify*):
   ☐ any table(s) related to the sequence listing (*specify*):

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/001080

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date (day/month/year)	Filing date (day/month/year)	Priority date (valid claim) (day/month/year)
JP 2004210597	29 July 2004	Unavailable	6 January 2003

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure (day/month/year)	Date of written disclosure referring to non-written disclosure (day/month/year)

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: V

In addition, Claim 1 is merely a reiteration of the laws of thermodynamics and kinetics. Irrespective of how the water is finally dissociated the following is an expression of how the reaction proceeds with an increase in temperature. It clearly shows that an increase in temperature will increase the number of dissociated H_2O molecules at or near the reactive or catalytic surface. In particular the reaction:

$$H_2O \rightarrow H_2 + \tfrac{1}{2}O_2$$

has an enthalpy of + 285.83 KJ/mol. Hence it is endothermic. Consequently the reaction follows the well known law of endothermic reactions, that is: "increased temperature favours the products". This is outlined in D13. The additional "restriction" introduced by way of Article 34 amendments, that "energy is added by the addition of steam instead of the energy provided as an applied electrical current" is merely substituting one form of energy for another and as a consequence the aforementioned and well known laws of thermodynamics still apply and there is no change in the scope of the claims. In the simplest terms the amount of energy required to convert:

$$H_2O \rightarrow H_2 + \tfrac{1}{2}O_2$$

remains constant irrespective of the pathway. Documents D5, D13 and D15 explicitly recognise this fundamental law of thermodynamics. The other documents take advantage of and implicitly recognise this law.

It is well understood that the reaction rate increases with an increase in temperature, again as outlined in D13. Documents D1 to D4 and D6 to D12 clearly disclose the application of these principles in the electrolysis of water, by elevating the temperature (in most cases to well above the boiling point of water) of the reactants during electrolysis. Consequently it is considered that claim 1 does not contain an element of novelty, nor does it involve an inventive step. It should also be noted that by definition a catalyst cannot change the equilibrium of the reaction. A catalyst simply increases the rate at which the reaction proceeds. Simply using steam to heat water irrespective of the catalyst (or reactive surface) used, or the final reaction temperature obtained is unlikely to produced a significant increase in the quantities of hydrogen fuel produced.

Document D14 by the applicant introduces the concept of combining two half cell reactions, with the idea of increasing hydrogen production. The teachings from this document may be combined with any of documents D1- D13 and D15 to produce a method of producing H_2 of the sort disclosed by D14 with an "increased number of dissociated H_2O molecules" near the reactive surface. Consequently claims 2 to 11 do not involve an inventive step.

The invention as defined in the present claims is therefore not Novel and does not have an Inventive Step when compared to the disclosures of the cited documents D1 to D15. The invention is industrially applicable.

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
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Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims		**YES**
	Claims	**1 to 11**	**NO**
Inventive step (IS)	Claims		**YES**
	Claims	**1 to 11**	**NO**
Industrial applicability (IA)	Claims	**1 to 11**	**YES**
	Claims		**NO**

2. Citations and explanations (Rule 70.7)

D1 = WO 2000/017418 A1 (The Regents of the University of California), 30 March 2000
D2 = GB 1490650 A (Blum P.), 2 November 1977
D3 = GB 2010333 A (Kernforschungsanlage Julich GmbH), 27 June 1979
D4 = WO 1994/012690 (Lasich J), 9 June 1994
D5 = EP 1006078 A1 (Yosohiro S et al.), 7 June 2000
D6 = DE 3101210 A1 (Dornier System GmbH.), 29 July 1982 & Derwent Abstract Accession No. 63841 E/31, Class E36, J03
D7 = DT 2549471 A1 (Dornier System GmbH), 12 May 1977 & Derwent Abstract Accession No. 34643Y/20 Class E36, J03
D8 = Derwent Abstract Accession No. 2000- 497491/44, Class E36, J03, PT 102238 A (Ramirez Garcia J.), 31 July 2000
D9 = Derwent Abstract Accession No. 47774B/26, Class E36, J03, JP 54-061088 A (Hitachi Shipbld Eng KK), 17 May 1979
D10 = Derwent Abstract Accession No. 47775B/26, Class E36, J03, JP 54-061089 A (Hitachi Shipbld Eng KK), 17 May 1979
D11 = Derwent Abstract Accession No. 33534 K/14, Class E36, J03, JP 58034183 A
= (Arakawa T), 28 February 1983
D12 = Derwent Abstract Accession No. 94-084061/11, Class X25, CN 1072465 A (Zheng J), 26 May 1993
D13 = "Physical Chemistry" 3rd Ed. P.W. Atkins, Oxford University Press, 1986. ISBN 0-19-855196-7.
D14 = WO 2000/070699 (Protegy Limited), 23 November 2000
D15 = "HYDROGEN PRODUCTION BY WATER SPLITTING USING MIXED CONDUCTING MEMBRANES"U. Balachandran, T. H. Lee, S. Wang, and S. E. Dorris February 2003, Manuscript to be submitted for publication in the Proceedings of the National Hydrogen Association's 14th Annual U.S. Hydrogen Meeting, Washington, DC, March 4-6, 2003.

The applicant's attention is directed to the document D5. This document clearly and unmistakeably discloses a process for generating hydrogen gas through direct thermal decomposition of water in which steam is used to heat water which is then passed under positive pressure and elevated temperature over a catalyst (zeolite) that separates hydrogen from the heated water. The invention defined in claims 1 to 11 is therefore not novel and does not have an inventive step when compared to the disclosure of D5.

Continued on supplemental sheet

screen may accept electrons from the electropositive system and transfer these to the water to a greater rate than would be observed if the electron transfer was only occurring directly from the electropositive system to the water.

More preferably, the enhanced reactor is an alkaline cell which uses a mesh cathode to provide electrons for the reduction of water according to the half cell equation:

$$2H_20 + 2e^- \longrightarrow 20H- + H_2 \qquad E^o = -0.828\ V$$

said half cell electro-chemical equation being coupled with another half cell reductant for the production of hydrogen. Desirably, the inert mesh cathode consists of platinised titanium to assist anodic corrosion thereby aiding electron transfer from the reductant.

Suitably, the reactions taking place in the enhanced reactor may proceed at an increased rate due to the heat added by the steam. As the reactions taking place in the enhanced reactor suitably have a net exothermic value when considered together, more heat may be produced than is consumed by any endothermic reactions also taking place in the enhanced reactor. In turn, this net increase in heat may further increase the rate of the reactions in the enhanced reactor.

It is also preferred that the reactions are selected such that the sum of the value of residual materials in the hydrogen cell at the endpoint of the reaction is greater than that of the sum of reactants introduced into the cell.

The enhanced reactor of the present invention preferably includes an associated heat exchange system that can be used to transfer heat from an exothermic chemical reaction in the cell or control the rate of the exothermic chemical reaction(s). The heat exchange system may operate by condensing the steam produced by the direct heating of the water in the aqueous system by the reaction. The heat exchange system may be used for other purposes (eg, domestic heating) or simply as a way of controlling the rate of reaction in the generator. It is known that increasing temperature increases the rate of a reaction.

Larger centrally located units for producing and distributing greater volumes of hydrogen and heat may use a continuous input of chemicals, introduced in batch mixtures at regular intervals and from which solutions of the value-added products can be removed. The recirculated cooling water may be used to replenish the

Claims:

1. An enhanced non-electrolytic energy production system for dissociating H_2O molecules at or near a reactive or catalytic surface, the system having the step of introducing steam at elevated temperature and a positive pressure into an enhanced reactor, wherein energy added to the reactor by the addition of the steam is used instead of energy provided as an applied electrical current by reaction systems in the reactor as activation energy.

2. An enhanced energy production system according to claim 1 wherein the steam introduced to the system is produced as a by-product of a method for generating hydrogen and/or energy from a chemical reaction including the steps of: selecting an electronegative half cell reaction producing hydrogen; selecting a first electropositive half cell reaction having a sufficient potential to drive said electronegative half cell reaction; selecting a second electropositive half cell reaction; said first and second electropositive half cell reactions selected in combination with said electronegative half cell reaction to produce an increase in hydrogen and/or energy production from water; and combining said half cell reactions.

3. An enhanced energy production system according to claim 1 further including a reaction system of one or more half cell reactions.

4. An enhanced energy production system according to claim 3 wherein the reaction system or half cell reactions require or are assisted by the provision of a reactive or catalytic surface.

5. An enhanced energy production system according to claim 3 wherein the reaction system includes on or more electropositive half cell reactions involving the oxidation of species selected from Group I or Group II metals, binary hydrides, ternary hydrides, amphoteric elements, electropositive elements in groups one and two of the periodic table and chelated transition elements, oxyacids of phosphorus and oxyacids of sulfur.

6. An enhanced energy production system according to claim 3, wherein the reaction system includes on or more electropositive half cell reactions involving a metal organic complex capable of changing configuration to release one or more electrons in a realisation of an increased co-ordination number.

7. An enhanced energy production system according to claim 3, wherein the reaction system includes the formation of a further semiconductive material or molecule.

8. An enhanced energy production system according to claim 7, wherein the semiconductive material or molecule is a composite material or molecule.

9. An enhanced energy production system according to claim 1, further including an associated heat exchange system that can be used to transfer heat from an exothermic chemical reaction in the cell or control the rate of exothermic chemical reaction(s).

10. An enhanced non-electrolytic energy production system for dissociating H_2O molecules at or near a reactive or catalytic surface, the system including a two part process for generating hydrogen and/or energy, the first part being a primary reaction system including the sub-steps of selecting an electronegative half cell reaction producing hydrogen; selecting a first electropositive half cell reaction having a sufficient potential to drive said electronegative half cell reaction; selecting a second electropositive half cell reaction; said first and second electropositive half cell reactions selected in combination with said electronegative half cell reaction to produce an increase in hydrogen and/or energy production from water; and combining said half cell reactions; and the second part including the introduction of steam produced as a by-product of the first step at elevated temperature and a positive pressure into an enhanced reactor, wherein energy added to the reactor by the addition of the steam is used instead of energy provided as an applied electrical current by reaction systems in the reactor as activation energy.

11. An enhanced energy production system having the step of introducing steam at elevated temperature and a positive pressure as the sole energy input into an enhanced reactor, wherein a portion of the energy added to the reactor system by the addition of the steam is used by reaction systems in the reactor to increase the number of dissociated H_2O molecules at or near a reactive or catalytic surface.